FACTORS INFLUENCING OCCURRENCE, SCALE, MOBILITY, RUNOUT, AND MORPHOLOGY OF MASS MOVEMENTS ON THE CONTINENTAL SLOPE.

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LONG-TERM GOALS

Achieve an improved understanding of the relationships between sedimentation, environment, and the morphology of continental slopes. This goal will be accomplished primarily through investigations within the northern California (Eel River) study area. An underlying assumption of our work is that the occurrence and morphology of mass movement features on the continental slope depend upon a combination of characteristics, each of which varies over the region in a consistent manner.

OBJECTIVES

Identify factors that can be mapped regionally and that determine where and how slope failures occur; derive a basis for producing regional maps that indicate relative landslide susceptibility.

APPROACH

Our research focuses on the factors that lead to variations in the sedimentological and environmental conditions determining slope failure. We develop improved correlations between engineering classifications and strength factors. We relate compressibility, physico-chemical properties and strength to sediment microstructure, observed using SEM techniques. We simulate sediment accumulation in specially designed large cells. We measure sediment rheological properties in a viscometer. Geotechnical properties are related to sediment density state, obtained from detailed logs of downcore variability of sediment density and sound velocity. Using available bathymetry, we construct slope maps. Seismic shaking variations are evaluated probabilistically by seismologists.

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Driving stresses are balanced against strength variations in a geographic Information System (GIS) to obtain a regional estimate of relative slope stability.
Key individuals: Homa Lee, Ken Israel, Pete Dartnell, and Greg Martz: physical property logs of sediment cores and relations between geotechnical and classification properties, algorithms relating sediment properties, environmental factors, and slope stability within the framework of a GIS. Jacques Locat, Marie-Claude Savoie, Éric Boulanger and Eric Allard: strength and compressibility measurements, SEM studies, rheology measurements, and simulation of sediment accumulation.

WORK COMPLETED

During an oceanographic cruise to the Eel Margin on the R/V Melville (July 18-28, 1997), we logged a total of 156 box cores and 46 piston cores at 1-cm resolution for density, sound velocity, and magnetic susceptibility. Some cores were tested for shear strength, shear wave velocity, and Atterberg limits. We entered these data into a GIS to evaluate regional variations in sediment properties and environmental loads. Algorithms convert these data into estimates of slope stability. Cores from 1996 were tested for compressibility, shear strength, microfabric, and rheology.

RESULTS

Classic slope failure features on the Eel Margin are rare even though our methodology shows a high vulnerability to slope failure during seismic loading, indicating either that mass wasting on the Eel Margin takes unexpected forms or that mass wasting is less significant than would be expected. Studies of shear strength development show a bi-linear function, resulting from bioturbation. Rheological studies of Eel Margin sediment show a highly thixotropic material, represented by a pseudo-Bingham model.

IMPACT/APPLICATIONS

Relationships developed in this project show the importance of sediment liquidity index and seabed density profiles in representing the behavior of marine sediment. These values can be used to predict regional slope stability and the rheological behavior of debris flows.

TRANSITIONS

Geoacoustic properties are being used by mappers and acousticians to identify lithologies acoustically. Rheological properties are being used by modelers to represent debris flows. Landslide generation models are being used by landscape evolution modelers.

RELATED PROJECTS

Lee has developed a USGS project to investigate sediment and pollutant transport on the Los Angeles margin that uses techniques produced by STRATAFORM. Locat is

investigating the behavior of a newly formed sediment layer acting as a natural cap over contaminated sediment in Canada. The development of this project benefited from approaches developed within STRATAFORM.

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